Saskatchewan
Environment and
Public Safety

Water Quality
Branch

A Guide to Aquatic Nuisances and Their Co. ol

December, 1986
WPC 47

Foreword

These guidelines are based on current knowledge about the control of aquatic nuisances. They also reflect pertinent regulatory requirements in effect at the time of writing. Please note that:

1. these guidelines are not intended to be used as a substitute for legislation or regulations;
2. the **product label** of registered pest control products provides **the most up-to-date and authoritative** source of information on the use of the particular product selected. Follow the procedures, and heed all the restrictions and precautions printed on the label; and
3. any mention of a trade name does not constitute endorsement by Saskatchewan Environment and Public Safety.

The Department would appreciate your comments on the usefulness of this publication and on your experience with the described control methods. Please address them to:

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1. Introduction

The purpose of this guide is to provide information on:

- characteristics of certain aquatic plants and animals to help identify what is causing the "nuisance";
- available control measures, their effectiveness in controlling different plants and animals and their possible side effects; and
- regulations governing aquatic nuisance control programs in Saskatchewan and the steps required to obtain a permit to control aquatic nuisances. **A permit from Saskatchewan Environment and Public Safety is required if chemicals are to be applied to any surface water or along the banks or shore of any surface waters in Saskatchewan.** (See Section 6).

Aquatic plants and animals play an indirect but important role in Saskatchewan's economy. Aquatic plants provide food and shelter for fish and waterfowl. Cattails and rushes reduce erosion by stabilizing shorelines.

Aquatic animals such as mosquitoes, leeches and snails are important links in food chains. When using control measures, efforts must be made to avoid harming non-target organisms such as honey bees, earthworms, farm and game birds and local fish populations.

"Aquatic nuisances" are those aquatic plants and animals which are present in sufficient numbers to pose problems for people or animals using a particular waterbody or its surrounding environment. An over-abundance of certain aquatic plants, for example, can foul beaches, cause water to become toxic or to have an unpleasant colour, taste or odour. Irrigation systems may become obstructed by aquatic plants. Algae can clog filters in water treatment plants. Recreational water uses may be limited by the presence of swimmer's itch or leeches.

Aquatic ecosystems represent a delicate balance of many factors. Measures to control one type of aquatic plant or animal can have undesired effects on other aquatic or terrestrial life. Effective and responsible control of aquatic nuisances requires knowledge of not only the control alternatives available but also of the types of aquatic plants or animals which may need to be controlled.

2. Planning an Effective Aquatic Nuisance Control Program

2.1 Evaluate the Problem

- Which organism is causing the problem?
- Is the problem:
  acute — needing treatment for only a short time?
  chronic — needing prolonged treatment?
  recurring — needing periodic, carefully timed treatment or preventative action?
- What is the nature of the water body involved?
- How serious or costly is the problem if left untreated?
- How effective is a local attack on the problem?

2.2 **Determine the Best Type of Intervention**

- No intervention;
- manual or mechanical control; or
- chemical control.

2.3 **Make a Plan to Control the Particular Nuisance**

If the treatment plan has to involve chemicals, select a control method or pesticide which is registered in Canada for the intended use. Careful consideration should be given to:

- effectiveness in curing the problem and suitability for the individual circumstances;
- side effects: health hazards, environmental impacts;
- formulation (e.g. liquid, granular) and mode of application (e.g. by hand, sprayer, aircraft);
- dosage: how much to use, how often and when;
- special situations: when and where **not** to use it, even though it is thought to be the best choice;
- duration of action: need for multiple treatments; and
- costs (Note: Over-treatment is costly and wasteful and can result in a build-up of chemicals and a resistance to their beneficial effects).

2.4 **Apply to Saskatchewan Environment and Public Safety for a Permit**

- Application forms for a permit are in the back of this booklet;
- for some control measures, additional permits may be required (e.g. Shoreline Alteration Permit, Drainage Control Permit);
- see Section 6 for details of regulatory requirements.

2.5 **Implement the Plan as Approved, Taking Adequate Safety Precautions**

- Keep pesticides out of reach of children and animals;
- ensure all containers are properly labelled;
- carefully follow all label instructions and precautions;
- in the event of a spill of the pesticide, notify the Saskatchewan Spill Control Centre 1-800-667-7525 (See Appendix A);
- dispose of pesticide containers in an environmentally acceptable manner (see Appendix B); and
- know pertinent first-aid measures and whom to phone in the event of an accident.

3. Nuisance Plants

3.1 **Description**

To control aquatic plants effectively, it is necessary to know the type of weed involved. Aquatic plants may be described as **emergent**, **submergent** or **floating**. The following three sections describe each type: the plants involved, some of the benefits they provide and the problems they may create.

3.1.1 Emergent Plants

Emergent plants (e.g. cattails) are anchored in one place by roots, and foliage characteristically extends well above the water surface. Emergent plants also can grow on exposed soil if the water table is sufficiently high.

Emergent plants help to stabilize shore areas and to prevent erosion. They serve as food for aquatic wildfowl and muskrats. They also provide important fish spawning and rearing habitat, and nesting sites for birds. Therefore, treatment areas should be kept to minimum size.

In excess, they may:

- interfere with access to beaches;
- choke shallow drainage ditches;
- increase silt deposition;
- reduce amount of water available for irrigation due to water use by plants;
- restrict water flow in irrigation systems; or
- obstruct canal or ditch maintenance.

The following are typical emergent water plants in Saskatchewan.

Figure 1 — Emergent Water Plants

Arrowhead
(Sagittaria cuneata)

Named from its leaves which usually are shaped like arrowheads. Submerged leaves may be narrowly linear. This plant grows in marshes and shallow areas or shores of lakes. The roots bear tubers, and the waxy white flowers occur in groups of 3. Height 20-40 cm (8-16 inches).

(Refs. Fassett 1957, Moss 1959).

Bulrushes
(Scirpus spp.)

The stems are green, cylindrical and may grow 2 cm (¾ inch) in diameter and 2½ metres (8 feet) tall in some species. Flowers may appear to grow from the side of the stem. The hard stem bullrush can grow in water up to 2 metres (6 feet) in depth. Other types are found in more shallow areas. Bulrushes are used for food by wildlife and are important as soil binders.

(Ref. Caldwell 1962).

Cattail
(Typha latifolia)

Cattails grow in thick patches from creeping root-stocks and often attain heights of 2½ metres (8 feet). They can grow on wet ground and in shallow water. The flowers form a dense, dark brown, cigar-like spike. Cattails provide excellent habitat for birds and small mammals.

(Ref. Fassett 1957).

Marsh Smartweed
(Polygonum coccineum)

This plant has dark green, shiny leaves which may either float on the surface or protrude above the water. The pink or white flowers grow in an erect spike above the water. The plant occurs both in shallow water and on wet land. Height 30-100 cm (12-40 inches).

(Refs. Caldwell 1962, Moss 1959).

Rushes
(Juncus spp.)

Found in moist areas such as the edges of lakes, ponds and marshes, rushes have round stems that can be hollow, pithy or partitioned. The leaves may be hollow, spear-like or flat. The green or brown flowers are borne on the end of the stem, but in some species, they may appear to grow from the side of the stem. Height 20-80 cm. (8-32 inches).

(Refs. Fassett 1957, Moss 1959).

Spikerush
(Eleocharis spp.)

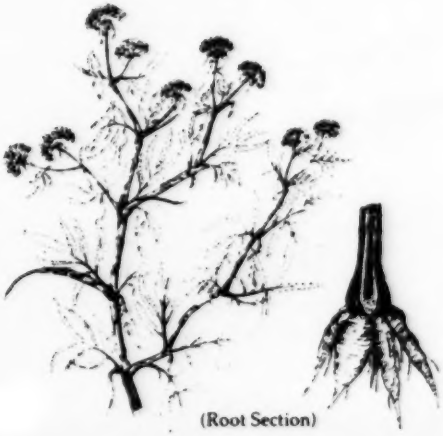
These plants occur along the edges of sloughs and ponds both in shallow water and on wet ground. The stems are green and leafless and end in a single spike. Height 10-100 cm (4-40 inches).

(Refs. Fassett 1957, Moss 1959).

Water Hemlock
(Cicuta maculata)

This plant grows in the shallows or on wet shores beside still or running water. The stems are hollow and usually erect. The long, narrow leaves are in groups of three. Small flowers are located at the tip of the stem on radiating stalks of equal length. Height 30-180 cm (1-6 feet). **It is extremely poisonous.**

(Refs. Fassett 1957, Cook 1974, Moss 1959).



Whitetop

(Fluminea festucacea)

This plant is a perennial grass associated with wet areas. It is topped with a whitish feathery branched flower cluster containing oat-shaped seeds. Height 1-1.5 metres (3-5 feet).

(Refs. Caldwell 1962, Fassett 1957).

3.1.2 Submergent Plants

Most submergent plants are anchored in one place with roots and have no foliage extending above the water surface.

Submergent plants are useful in providing shelter for fish and can also help oxygenate the water. They serve as food for waterfowl, muskrats and moose.

In excess, they may:

— restrict carrying capacity in irrigation canals;

— choke pump inlets; or

— reduce the recreational quality of lakes and streams.

The following are typical submergent water plants in Saskatchewan.

Figure 2 — Submergent Water Plants

Bladderwort

(Utricularia vulgaris)

Bladderworts are rootless plants which float just below the surface of ponds, lakes and streams. The threadlike leaves bear small, brown bladders (3-5 mm long) which act as a trap for small animal life. Flowers are yellow and extend above the water surface on long stalks.

(Ref. Caldwell 1962).

Coontail

(Ceratophyllum demersum)

Coontail is a rootless submergent plant with spike-like leaflets. Each leaf is forked into 2 or 4 toothed divisions. It is so-named because of the densely bushy stem tips. Stems 30-150 cm (1-5 feet) long.

(Refs. Caldwell 1962, Moss 1959).

Richardson's Pondweed

(Potamogeton richardsonii)

Richardson's pondweed grows in lakes, ponds and slow streams. The leaves (3-12 cm long) have smooth, wavy margins, clasping bases and may appear to be striped. Flowers are borne on thick spikes which may rise above the water surface.

(Ref. Fassett 1957).

Sago Pondweed

(Potamogeton pectinatus)

Grows in a wide range of aquatic settings including swift water. The finely dissected leaves of this plant are triangular in cross section and 3-10 cm long. Stems are slender with many branches. Sago pondweed is a rooted plant but the stems often break loose and collect in rows along shorelines.

(Ref. Fassett 1957).

Stoneworts
(Chara and Nitella)

Both types of plants (actually algae) occur submerged in lakes and slow-moving streams in which calcium is abundant. Frequently they are encrusted with lime deposits and so feel coarse or gritty to the touch. While they serve to anchor a lake's sediment, they may also impart very obnoxious tastes and odours to the water. Since these plants are really algae, they may not respond to the herbicides normally used to control submergent vegetation. Stems 2-60 cm (1-24 inches) long.

(Ref. Fassett 1957).

Water Milfoil
(Myriophyllum exalbescens)

The feather-like leaves of this plant are located in whorls, usually four to a whorl. The flower spikes project above the surface of the water. Milfoil usually is found rooted in dense beds in lakes, ponds and streams. Stems commonly about 1 metre (40 inches) long.

(Refs. Caldwell 1962, Moss 1959).

3.1.3. Floating Plants and Algae

Floating plants and algae may or may not be anchored. The unattached types are moved around on or just below the water surface by currents or winds.

Algae are tiny plants, most of which are microscopic in size. Algae is very common in Saskatchewan lakes. The presence of algae is necessary for the normal health of a lake. Beneficial roles of algae include its importance as a primary link in the aquatic food chain; nutrient cycling; and oxygen regeneration. However, a few types, particularly certain blue-green algae such as *Anabaena* sp. may become over-abundant in fertile warm lakes and create problems for water users.

Growths of algae dense enough to colour the water are called "blooms". On calm sunny days the bloom-forming algae tend to float at the surface of a lake or slough and form a scum. These blooms are most often caused by blue-green algae. A light wind or water currents may cause this scum to drift to shore. Heavy winds generally will mix the algae into the water.

Excessive algae may:

- cause taste and odour problems in raw water supplies;
- clog filters in water treatment plants;
- reduce carrying capacity of water distribution systems; or
- foul pump inlets, irrigation siphon tubes and sprinkler heads; or
- foul shorelines and interfere with recreational uses of water.

Excessive blue-green algae blooms also may cause sickness or death in livestock or pets if consumed.

Since most algae are microscopic and individuals are not normally seen with the naked eye, none are illustrated here.

Floating vascular plants may be either completely free-floating or they may have floating leaves with stems rooted in the bottom mud. They provide food for many birds, muskrats and moose, and shelter and shade for fish.

In excess they may:

- clog siphon tubes, trash racks and pump inlet structures; or
- interfere with recreational uses of water.

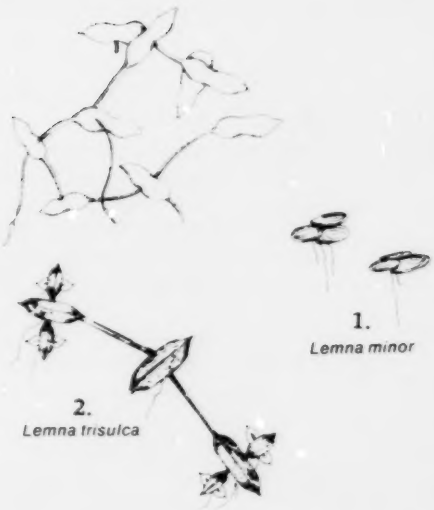
The principal floating plants in Saskatchewan are Duckweeds and Water Lilies, shown in the following illustrations.

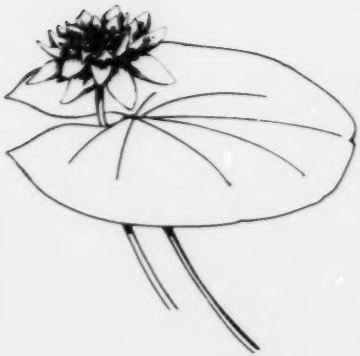
Figure 3 — Floating Water Plants

Duckweeds
(Lemna spp.)

These are very small plants (3-15 mm or ⅛ - ⅝ inch long). They may form a mat covering the surface of protected shallow bays or ponds. While these mats may resemble scums produced by algae, duckweed mats are not affected by copper sulfate treatments. These plants are **not** toxic and are commonly eaten by waterfowl.

(Refs. Cook 1974, Fassett 1957).





Yellow Water Lily
(Nuphar variegatum)

The thick, fleshy leaves of this pond plant arise from a creeping underground stem. The leaves and yellow flowers float on the surface of sheltered waters. Broadly oval leaves are 10-30 cm (4-12 inches) long. Young submersed leaves are often red tinged.

(Ref. Moss 1959).

3.2 Control Measures

Non-chemical treatment should be selected whenever possible. The sections which follow discuss the alternatives of mechanical and chemical control for different categories of aquatic nuisance plants.

If a chemical control method must be used, Table 1 provides a list of selected pest control products. This table may be used to identify a short list of products suitable for a particular aquatic environment (e.g. irrigation ditches, lakes, etc.) or a specific plant category (e.g. emergent, submergent, etc.). In addition, the product label should be consulted and closely followed.

3.2.1. Control of Emergent Plants

Mechanical:

This is the preferred technique, especially for small areas around beaches and boat docks. Cutting may be done by hand with a sickle or with a motorized mower. If at all possible, the root system should be removed to reduce plant regrowth. All plant material should be disposed of on land, not in the water. This will prevent fouling of beaches and reduce the chance of regrowth from plant cuttings.

Chemical (see Table 1):

Chemical control should be used only when mechanical control is not feasible due to the size of the area infested or difficulty of access (e.g. irrigation canals). See also Section 3.2.4.

Note that a shoreline alteration permit may be required (See Table 3).

3.2.2 Control of Submergent Plants

Mechanical:

On a small scale, mechanical removal can effectively control unwanted aquatic plants. Large-scale operations may involve the purchase, rental or lease of expensive harvesters. However, sufficient weeds can often be removed to clear a dock area by pulling them out by hand or with an ordinary garden rake. Several aspects should be considered:

- try to pull as much of the plant as possible, including the root system;
- keep the plants intact; if broken up, each small piece (depending on species) may produce a new plant; and
- remove all plant material from the water and dispose of it on land to prevent fouling of adjacent shorelines.

Light Reduction:

Plants require sunlight to grow. Placing commercially available bottom barriers such as Dartek® or black polyethylene plastic on a lake bottom will effectively reduce

the light reaching the plants and stop their growth. Such bottom barrier materials should be placed on the lake bottom in early spring and weighted with rocks or sand bags. Cutting small slits in the material will facilitate venting of gases formed by decomposition processes below the barrier. This treatment should reduce or eliminate plant growth for several years with little or no maintenance. This treatment works best in undisturbed areas.

Some chemical products also work by reducing available light (e.g. Aquashade).

Chemical (see Table 1):

For lakes and reservoirs, herbicides should be considered only as a last choice option due to the fact that most of these products are directly toxic to invertebrates. These chemicals may be used separately or in combination. Diquat for example is commonly used alone or can be combined with Paraquat in a 1:1 mixture. Also see Table 3. Note that excessive inhibition of submergent plant growth may lead to increased algal growth due to reduced assimilation of nutrients by these plants. Also, the elimination of one plant species can result in the invasion of other plant species which may be even more noxious.

3.2.3 Control of Floating Plants and Algae

Mechanical:

Satisfactory mechanical methods to control algae are still in the research and development stage. Floating vascular plants such as water lilies can be hand cut or removed by harvesting machines.

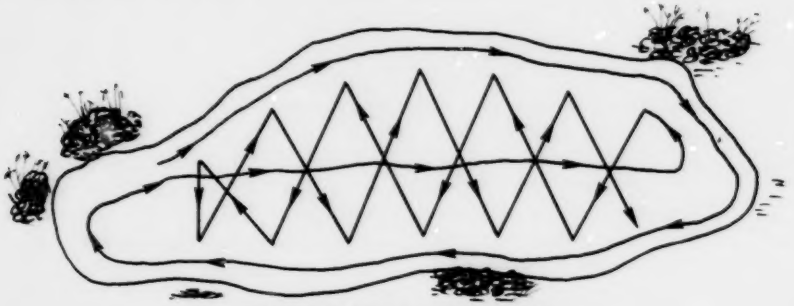
Chemical:

Because algae are moved around in lakes by wind and wave action, it is not effective to treat small areas. Also, control of algae in an entire lake is not only expensive, but is generally environmentally undesirable. As such, chemical control of algae is **only** advisable for small dugouts, ponds and municipal water supply reservoirs.

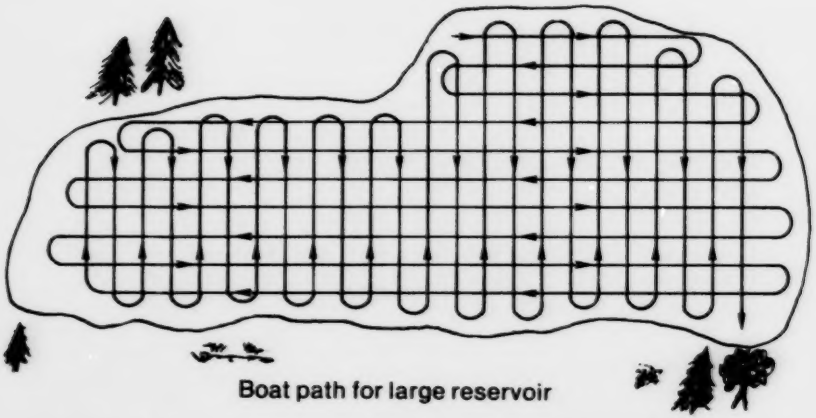
Copper Sulphate (bluestone): This is one of the most effective and inexpensive chemicals for treatment of algae. This and other products designated for algae control (e.g. Aquashade) are summarized in Table 1.

Figure 4 — Copper Sulphate: Application Methods

Two methods (patterns) to use when treating a dugout or reservoir with copper sulphate by boat:



Boat path for small reservoir



Boat path for large reservoir

The copper sulphate may be dissolved in water and applied to the pond surface as a spray, or it may be placed in a fine mesh bag (e.g. burlap sack) and dragged through the water until it has dissolved. It is most effective when the water temperature is 16°C or higher.

The recommended rate of application is 6.2 kilograms/hectare (5.5 pounds/surface acre) for control of algae. Dosages in excess of this can be toxic to fish and wildlife and must be avoided. Broadcasting copper sulphate crystals onto the surface of the water is **not** effective. Treatment should be carried out in successive "bands" as shown in Figure 4, covering not more than 1/4 to 1/3 of the surface at a time, but treating the entire area. Treatment should begin in early June or as soon as the water shows any green colouration. Treatments may be required at two-week intervals until late September.

3.2.4 Irrigation Canals, Ditches and Drainage Ditches

Irrigation canals, ditches and drainage ditches present special problems of weed control for the following reasons:

- the effective movement of water depends on weed-free conditions;
- aquatic nuisance plants in canals and ditches may include representatives from the emergent, submergent and/or floating categories; and
- when canals and ditches are dry for any period of time, they are susceptible to invasion by dry land weeds or brush.

Mechanical:

Mechanical methods are recommended to clear brush in drainage ditches.

Chemical (see Table 1):

See Sections 3.2.1, 3.2.2, and 3.2.3 for appropriate control measures of nuisance aquatic plants.

For irrigation canals, the chemical applied should be short-lived so that the water supply can be returned to use.

There are a number of restrictions specific to irrigation canals, ditches and drainage ditches:

(i) Roundup (glyphosate): This chemical is not Federally registered for use in and around irrigation canals. It can however be used in and around dry irrigation and drainage ditches.

The use of Roundup is subject to the following conditions:
- it may be used only on dry ditches;
- it must not be sprayed over or beside standing water; and
- the ditch must remain dry for seven days following treatment.

(ii) 2, 4-D: This chemical is registered for use in and around **dry** drainage ditches. It must not be used in and immediately around active drainage areas or any surface water body. This chemical should not be used within 25 metres (92 feet) of the high water line because:
- minute quantities can cause objectionable tastes and odours in chlorinated water supplies and fish;
- the compound is water soluble and may damage desirable aquatic vegetation; and
- 2, 4-D has been shown to persist up to 6 weeks in water and up to 10 months in sediments. 2, 4-D must **not** be used to control weeds or brush in or immediately around irrigation ditches or canals.

At present Roundup (glyphosate) and 2, 4-D are the only effective chemicals registered for control of woody growth in drainage projects. Mechanical methods are the preferred alternative control measure.

Table 1
Aquatic Nuisance Plants:
Summary of Pest Control Products[1]
(Revised December 1986)

Product Name and Active Agent	Aquatic Settings for Which Product is Registered				Types of Plants Generally Controlled			
	Drainage Ditch	Irrigation Canal, Ditch	Farm Pond or Fish Pond	Lake, Pond, Stream, Swamp	Emergent	Submergent	Floating	Algae
Magnacide H Acrolein		•				•		• (filamentous)
Amino-Triazole Amitrole	•			• (marsh only)	•			
Amitrole 90 Amitrole	•			• (marsh only)	•			
Cytrol Amitrol T Amitrole	•			• (marsh only)	•			
Wilson Poison Ivy & Brush Killer Ammonium sulfamate	• (dry)				• (bank plants, brush, trees)			
Algimycin PLL-C Copper			• (not for use in public or potable water systems)					•
Algimycin PLL-C Slow Release Copper			• (not for use in public or potable water systems)					•
Cutrine-Plus Granular Copper			• (not for use in public or potable water systems)					•
Cutrine-Plus Liquid Copper			• (not for use in public or potable water systems)					•
Bluestone (Copper Sulphate)			•	• (pond)				•

Dowpon Wettable Powder Grass Killer Dalapon	•		•		•			
Basfapon Soluble Powder Herbicide Dalapon	•	• (ditch)			•			
Dowpon M Grass Killer Dalapon	•		•		•			
Regione A Diquat	•		•	•		•	•	• (filamentous algae)
Norkem 500 Diquat	•		•	•		•	•	
Cantol 450 Liquid Weed Killer Diquat	•		•	•	(only for use in water bodies wholly confined to user's property)	•	•	•
Karmex Weed Killer Diuron	• (dry ditches)	•	•		• (weeds)	•		•
Marzone Weed Killer Diuron	• (dry ditches)	•			• (weeds)			
Pfizer Diuron 80W Diuron	• (dry ditches)	•			• (weeds)			
Diurex 80W Herbicide Diuron	• (dry ditches)	•			• (weeds)			
Diurex 80W Diuron	• (dry ditches)	•			• (weeds)			
Chipman 2,4-D Amine 500 2,4-D as dimethylamine salt	• (dry)				• (weeds, brush)			

Table 1 (continued)
Aquatic Nuisance Plants:
Summary of Pest Control Products[1]
(Revised December 1986)

Product Name and Active Agent	Aquatic Settings for Which Product is Registered				Types of Plants Generally Controlled			
	Drainage Ditch	Irrigation Canal, Ditch	Farm Pond or Fish Pond	Lake, Pond, Stream, Swamp	Emergent	Submergent	Floating	Algae
Green Cross 2,4-D Amine 500 2,4-D as dimethylamine salt	• (dry ditches)	•			• (weeds, shrubs)			
Amkil 500 2,4-D Amine 2,4-D as dimethylamine salt	• (dry)				• (weeds, brush)			
Amkil 500 2,4-D 2,4-D as dimethylamine salt	• (dry)				• (weeds, brush)			
Dimine Weed Killer 2,4-D as dimethylamine salt	• (dry ditches)	•			• (weeds, brush)			
Spray Stuff Amine 500 2,4-D 2,4-D as dimethylamine salt	• (dry ditches)	•			• (weeds, brush)			
Spray Stuff Amine 600 2,4-D 2,4-D as dimethylamine salt	• (dry ditches)	•			• (weeds, brush)			

Chipman 2,4-D Ester 500 2,4-D as iso-octyl ester	● (dry)					● (weeds, brush)		
Chipman 2,4-D Ester 600 2,4-D as iso-octyl ester	● (dry)					● (weeds, brush)		
Aqua-Kleen 20 Granular Weed Killer 2,4-D as butoxyethanol ester	●		● (farm)	●			●	●
Guardsman 2,4-D Ester 80 L.V. Weed Killer 2,4-D as iso-octyl ester	● (dry)					● (weeds, brush)		
Roundup Liquid Herbicide Glyphosate as isopropylamine salt	● (dry ditches)	●				● (cattails, weeds, brush)		
Estakil 500 MCPA	● (dry)					● (weeds, brush)		
Gramoxone Liquid Agric. Herbicide Paraquat	●		● (farm)	●		●	●	●
Gramoxone S Liquid Herbicide Paraquat	●	●	● (farm)	●		●	● (1:1 mix with Reglone A)	●
Princep 80W Simazine	● (no flow)			● (ponds)		●	●	● ●

Table 1 (continued)
Aquatic Nuisance Plants:
Summary of Pest Control Products[1]
(Revised December 1986)

Product Name and Active Agent	Aquatic Settings for Which Product is Registered				Types of Plants Generally Controlled			
	Drainage Ditch	Irrigation Canal, Ditch	Farm Pond or Fish Pond	Lake, Pond, Stream, Swamp	Emergent	Submergent	Floating	Algae
Simmaprim 80W Ind. Simazine	• (no flow)			• (ponds)	•	•	•	•
Simadex Simazine Flowable Herbicide Simazine	• (no flow)			• (ponds)	•	•	•	•
Princep Nine-T Simazine	• (no flow)			• (ponds)	•	•	•	•
Later's Simazine 80 WP Herbicide Simazine	• (no flow)			• (ponds)	•	•	•	•
Aquashade Water Soluble Dye			•			• (will suppress growth)		•

[1] Product registrations can change without notice; read label instructions and usage restrictions carefully before use.

4. Mosquitoes

4.1 Description

Most people are annoyed by mosquitoes during the summer. Some of us can avoid most of this nuisance problem, but it is a more insistent concern for vacationers and outdoor workers including farmers. Some mosquitoes also are a nuisance to livestock and can cause them considerable stress. Most mosquito species are not a threat to health; nevertheless, certain types can carry viruses capable of producing encephalitis, an infection of the central nervous system.

The mosquito-borne disease of greatest concern in Saskatchewan is Western Equine Encephalitis (WEE). This disease has occurred in modest epidemic form on the prairies affecting many horses and several people on sporadic occasions. Only one or two of the many kinds of mosquitoes in Saskatchewan can carry WEE. A surveillance and control program is in place to ensure that outbreaks of WEE are prevented. For further information on this disease and its prevention, contact:

Virus Encephalitis Research
Department of Veterinary Microbiology
Western College of Veterinary Medicine
Saskatoon, Saskatchewan S7N 0W0
Phone 966-7210

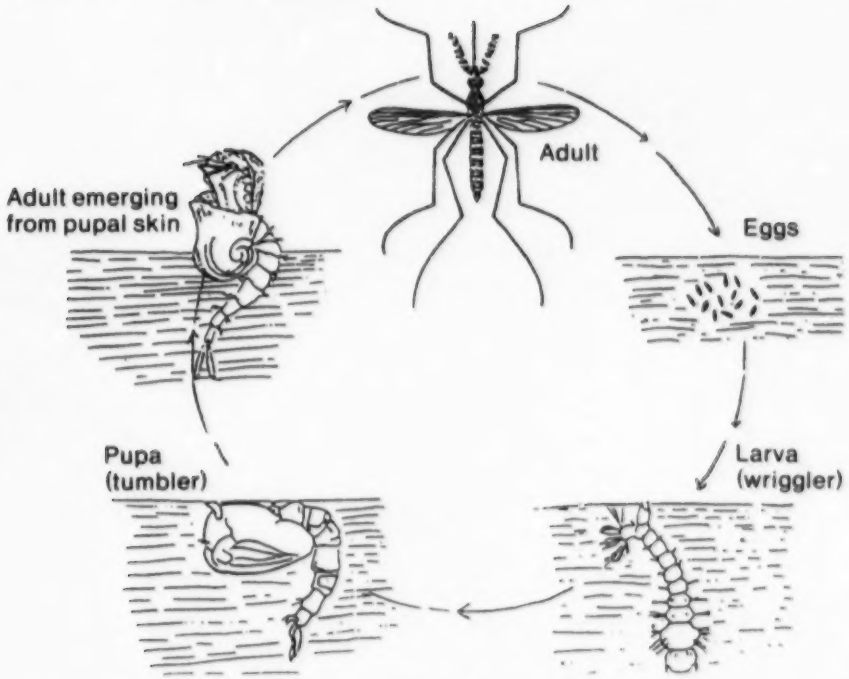
Mosquitoes develop through four stages in their life-cycle: egg, larva, pupa, and adult (see Figure 5). Hatching of the egg, and development of the larva and pupa can only occur in water. These pre-adult stages of the mosquito obtain oxygen directly from the air, and so can inhabit sluggish, poorly aerated waters, such as the edges of swamps, temporary pools of meltwater or floodwater, weedy shallows of ponds and small volumes of water in catch basins in storm sewer systems, at the ends of culverts, garden ponds, and water trapped in discarded tires and unpunctured, unburied containers. These are, in fact, preferred breeding places for most mosquitoes.

Development of mosquitoes is unsuccessful in open, well aerated bodies of water or in running streams.

The larvae are popularly called "wrigglers", from their characteristic motion as they travel to and from the surface where they breathe through their "tail". After three moults, the mosquito is in the pupa stage. This has a relatively large "head", and breathes at the surface without the "wriggler" motions. Finally, at the end of development, the adult emerges from the split pupal skin.

The details of this life-cycle vary considerably from species to species among the mosquitoes. Details that vary include: preferred host, preferred breeding habitat (temporary or permanent water bodies), preferred water temperature, emergence time, duration of each life stage, and number of generations per season. Consequently, effective control of larvae (larviciding) requires considerable knowledge of the biology of the particular mosquito species.

Figure 5 – Life Cycle of Mosquito



Taken from "Controlling Mosquitoes and Blackflies in Ontario". Ontario Ministries of Environment, Health and Natural Resources, 1981.

4.2 Control Measures

4.2.1 Preventing the Mosquito Problem

Because this pest often does not fly very far and breeds in small aquatic habitats which are rarely very useful for man, **control by habitat reduction is a viable option:**

- puncture, crush, and/or bury "dump" items that can otherwise trap and hold snowmelt and rain water;
- correct and prevent recurrence of erosion pits at the end of culverts, standing water trapped in culverts, and seepage ponds in irrigated areas; and
- consider draining swamps, recontouring pond margins, and channelizing excessively meandering streams – **providing** that these modifications are environmentally sound in the affected location.

A combination of breeding area reduction and insecticide treatment usually provides the most economical and efficient control of mosquitoes. The effects of habitat reduction are usually long-term and permanent, while pesticides provide only temporary control.

4.2.2 **Chemical Control of Mosquitoes**

For active chemical control of mosquito numbers, there are two basic approaches:

(i) Killing adults in the aerial or land environment when they are old enough to bite (adulticiding). This method is **not** very effective. Also, terrestrial or aerial spraying of adult mosquitoes is usually prohibited near aquatic systems.

(ii) Killing larvae in the water before adults emerge (larviciding).
The low mobility of larvae (in contrast with the adults) makes selective use of the pesticide quite feasible. The remainder of this section focuses on mosquito larvicide programs.

(a) **Planning**

A good, cost-effective and environmentally sound larviciding program for mosquito control requires careful planning. Larviciding is sometimes effective on a single parcel of private property. But normally, due to the distances mosquitoes may fly or be carried by breezes, effective control calls for joint action by a number of neighbours or by a municipality.

Key factors in planning and implementing a successful program are:

- carry out a mosquito survey in the area where control is desired and for several kilometres adjacent to this area, concentrating on areas up-wind;

- determine and map the mosquito breeding sites, paying special attention to the places flooded for only a few weeks in the spring. Such a map must accompany the application for a permit. This can be a section of a topographic map. A contour map (1:50,000) or a Township Photomap is recommended. These are available from:

  Map and Photo Library
  Central Survey and Mapping Agency
  Saskatchewan Property Management Corporation
  2045 Broad Street
  Regina, Sask. S4P 3V7
  Phone 787-2799 or 787-2800

- work out in advance the routes for control equipment to follow into and through the treatment area;
- if possible, arrange for workers from the area to carry out the observations and treatment because

they will be most familiar with the terrain and its problems and are more likely to be available to continue control work in future years;

— collate the information on all the above points before formulating the mosquito control program; and

— update the information on the area each year with an early survey of breeding sites since these depend upon factors which can change from year to year.

(b) **The Survey**

Effective control depends upon an accurate biological survey. An accurate survey should:

— start in early spring;

— locate the actual breeding areas;

— map the abundance of larvae;

— determine how developed the larvae are; and

— identify and map the wet areas where larvae are present and also where they are absent.

(c) **Treatment Timing**

Mosquito larvidicing is best carried out when the larvae are about half-way in their development toward the pupal stage. They should be roughly 5 to 10 millimetres long. These guidelines are adequate for the more conventional larvicidal chemicals. For insecticides that work by altering development, more precise identification of the stage of development is essential. The target is usually a stage near pupation, as indicated on the product label.

If the severity of the problem warrants, second generation mosquito larvae may be treated later in the season. In any case, the effectiveness of the program should be determined through regular follow-up surveys. Such surveys may indicate a need for repeat treatment.

(d) **Treatment of Larval Stage Mosquitoes**

The products in Table 2 are registered for use as mosquito larvicides. (They are useless against pupae. If for some reason populations of pupal stages must be treated, refer to section (e), "Treatment of Pupal Stage Mosquitoes").

Chemical: (see Table 2)

Method of Application

Treat only the documented breeding areas. Carefully follow the instructions on the label. Use only the

recommended means of application. Larvicidal formulations may be spray concentrates, granules, or capsules, and hence need to be distributed in different ways.

Treatment by spraying from aircraft requires special planning.

Table 2
Mosquito Larvicides: Products Registered in Canada
A. For Application from the Ground[1]
Revised December 1986

Active Agent	Product Name	Class*	Special Conditions	Minimum Period Between Applications	Dilution
Bacillus thuringiensis (serotype H-14)	Bactimos	BC	See label.		
	Teknar	BC	See label.		
	Vectobac	BC	See label.		
chloropyrifos	Dursban 2E	PT	See label.	2 weeks	Water or fuel oil.
	Dursban 4E	PT	See label.	2 weeks	
	Dursban 2½ G	PT	See label.	2 weeks	
	Dursban M	PT	See label.	2 weeks	
diflubenzuron	Dimilin 25WP	GR	For control of flood water **Aedes** and **Culex** species.		Water only.
fenthion	Baytex Liquid Conc.	PT	See label.	3 weeks	Water with emulsifier, or fuel oil.
	Baytex Spray Conc.	PT	See label.	3 weeks	Water only.
	Fenthion 50E	PT	See label.	3 weeks	Water only.
malathion	Malathion	PD	See label.		Water or fuel oil.
methoprene	Altosid Briquet	GR	**Aedes** and **Culex** species.		
	Altosid SR 10%	GR	2nd to 4th instars only, **Aedes** species only.		Water only.
mineral oil	Flit MLO	MO	Also active against pupae.		None.
pyrethrin	Skeeter Bombs	PR	See label.		
	Waco Tossit	PR	See label.		
temephos	Abate 2G	PT	Use the higher rate in deeper pools or pools with high organic matter.		
	Abate 4E	PT	See label.		Dilute with sufficient water for uniform coverage.

[1] Product registrations can change without notice; read label instructions and usage restrictions carefully before use.

* **Class Codes:** BC = biological control agents; GR = growth (development) regulatory; MO = mineral oils; PD = phosphorodithioates; PR = Pyrethroid; PT = phosphorothioates.

Table 2 — Continued
B. For Application from Aircraft[1]
Revised December 1986

Active Agent	Product Name	Class*	Special Conditions	Minimum Period Between Applications	Dilution
Bacillus thuringiensis (serotype H-14)	Bactimos	BC	See label.		
	Teknar	BC	See label.		
	Vectobac	BC	See label.		
chloropyrifos	Dursban 2E	PT	See label.	2 weeks	Water or fuel oil.
	Dursban 4E	PT	See label.	2 weeks	
	Dursban 2½ G	PT	See label.	2 weeks	
	Dursban M	PT	See label.	2 weeks	
diflubenzuron	Dimilin 25WP	GR	For control of flood water **Aedes** and **Culex** species.		Water only.
fenthion	Baytex Liquid Conc.	PT	See label.	3 weeks	Water with emulsifier, or fuel oil.
	Baytex Spray Conc.	PT	See label.	3 weeks	Water only.
	Fenthion 50E	PT	See label.	3 weeks	Water only.
malathion	Malathion	PD	See label.		Water or fuel oil.
methoprene	Altosid SR 10%	GR	2nd to 4th instars only, **Aedes** species only.		Water only.
methoxychlor	Methoxychlor 240	MC	See label.		Oil and water.
mineral oil	Flit MLO	MO	Also active against pupae.		None.
temephos	Abate 2G	PT	Apply the higher rates to deeper pools.		
	Abate 4E	PT	See label.		Dilute with sufficient water for uniform coverage.

[1] Product registrations can change without notice; read label instructions and usage restrictions carefully before use.

* **Class Codes:** BC = biological control agents; GR = growth (development) regulatory; MC = methoxychlor type; MO = mineral oils; PD = phosphorodithioates; PT = phosphorothioates.

Rate of Application

Consult and follow the instructions exactly as printed on the label.

Frequency of Application

Follow the recommendations and heed any restrictions printed on the product label. For a general guide, see Table 2.

Restrictions and Precautions

Wet areas not containing larvae should not be treated with insecticides.

Treatment of wet areas where larvae are not abundant would be inefficient, expensive and may be environmentally damaging.

Many mosquito larvicides work by disabling the insect's nervous system. These chemicals may have similar effects on the nervous systems of other animals, including man. Therefore, precautions on the labels must be rigorously observed.

Most products are only registered for use in standing waters wholly confined to users property with no outflow to adjacent lands or water courses.

Follow Through

The effectiveness of treatment and the need to repeat larviciding should be assessed through regular follow-up surveys.

These surveys should be done:

— 24 hours after the treatment;

— once a week throughout the breeding season; and

— one to two days after heavy rains from midsummer to early fall.

If using insecticides which alter development, larval counts cannot be used as a criterion for treatment effectiveness. In this case, subsequent non-emergence of normal adult mosquitoes is the criterion.

(e) **Treatment of Pupal Stage Mosquitoes**

Treatment of the pupal stage (pupiciding) should not be necessary in most instances where adequate planning and systematic, early field surveying has been done. Nevertheless, if circumstances dictate, pupiciding may be undertaken. At present only one type of chemical product is registered for this use, and it asphyxiates the pupae by making surface breathing impossible.

Chemical: (see Table 2)

Mosquito Larvicidal and Pupicidal Oil.

Method of Application

Consult the current product label for details about application and precautions.

Apply as a fine spray to minimize impact on water surface.

Use hand or power sprayer, mist machine or aerial application.

Rate of Application

	Condition of Area to be Treated	Litres per hectare
(i)	**Ground Application**	
	None to medium vegetative cover. None to little surface debris.	22-35
	Medium to heavy vegetative cover. Heavy surface debris or waters high in organic content.	35-55
	Ponds containing untreated or partially treated sewage waste.	55
(ii)	**Aerial Application**	
	None to medium vegetative cover.	11-22
	Medium to heavy vegetative cover.	22-35

Frequency of Application: Apply as needed when reinfestation occurs.

Restrictions and Precautions

This is a restricted product for non-adult mosquito control in residential areas, municipalities, rural areas, swamps and woodlands.

Do not add emulsifiers or spreading agents.

Moderate to heavy rainfall within six hours after application may reduce effectiveness.

Follow Through

The effectiveness of treatment and the need to repeat pupiciding should be assessed through regular follow-up surveys.

5. Other Aquatic Nuisances

5.1 Leeches

Leeches are slow-moving creatures related to the common earthworm. A few species cling to waders and swimmers, and suck blood from their skin. The leeches are easy prey to fish and generally become a problem only in areas without resident fish populations.

Leeches can sometimes be controlled by stocking fish in the waterbody. Permission to do this may be obtained through the local Conservation Officer, Saskatchewan Parks and Renewable Resources.

Chemicals:

Copper sulphate (bluestone)

Method of Application

Place the chemical in a burlap sack and drag behind a boat until the copper sulphate is dissolved. (See Section 3.2.3.)

Rate of Application

56 kilograms/surface hectare (50 pounds/surface acre).

Frequency of Application

As required, but not more often than once every two weeks.

Restrictions and Precautions

No swimming for 24 hours after treatment.

No consumption of the water for 24 hours after treatment.

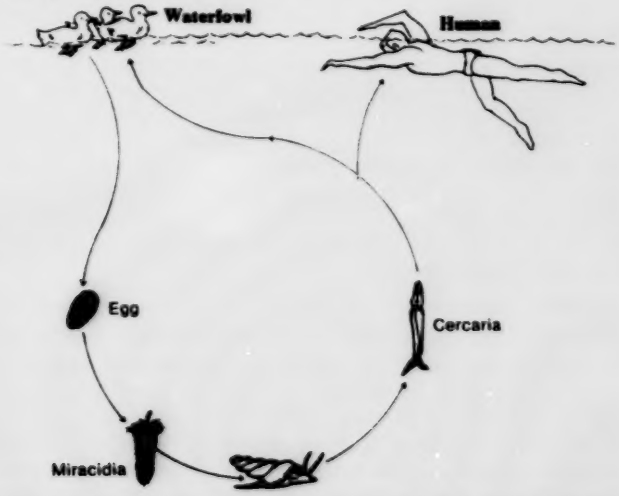
This chemical is very toxic to fish at this rate of application.

5.2 Swimmer's Itch (Schistosome Dermatitis)

Swimmer's itch is a temporary infection caused by a tiny trematode worm which spends parts of its life inside certain snails. The parasite **(Schistosoma dermatosa)** emerges from the snail as a larva (cercaria) during warm weather and must find another host (usually waterfowl) within 24 hours (see Figure 6). The cercaria will burrow into the bird's skin and continue to develop into an adult worm (Schistosome).

Swimmer's itch occurs when the cercariae accidentally try to burrow into human skin. Since man is an unsuitable host, the cercariae are quickly destroyed. This causes an allergic reaction and skin irritation.

Figure 6 — Life Cycle of Swimmer's Itch



The parasites burrow into the swimmer's skin when it begins to dry. Swimmers can therefore control the itch by towelling the body dry or taking a shower in fresh water immediately after leaving the water. This removes the parasites from the skin. The shower must be located at the beach site with a water supply other than the lake.

Chemical:

Copper sulphate (bluestone): See Section 5.1 for information on methods and restrictions.

Niclosamide (Bayluscide): This chemical may also be used, but only by specially trained personnel under programs approved by Saskatchewan Agriculture.

Consult current product label for detailed information on Bayluscide application rates and use restrictions:

- treat only those areas where surveys have shown snail beds to be present;
- to minimize the hazard to fish, apply to only 1/3 of a selected treatment area at a time, and apply the chemical from shoreline outwards;
- wait 24 hours between applications at each site;
- Bayluscide is toxic to freshwater clams and mussels; and
- may be toxic to those fish which cannot or will not leave the lake bottom.

Niclosamide may be harmful to humans and animals if swallowed directly but the mechanism of its toxic action is unknown.

5.3 Fish

The control of fish in any surface water in Saskatchewan is regulated through Fisheries Branch, Saskatchewan Parks and Renewable Resources.

For information on fish control, contact:

Fisheries Branch
Saskatchewan Parks and Renewable Resources
Box 3003
Prince Albert, Sask.
S6V 6G1
Phone 953-2888

or:

3211 Albert Street
Regina, Sask.
S4S 5W6
Phone 787-2884

6. Policies and Regulations

6.1 General

Limited, localized use of chemicals is acceptable for control of aquatic nuisances. Such chemicals must, however, be used with extreme caution. Label regulations and restrictions imposed by Agriculture Canada must be followed. Use of chemicals not included in this publication may be permitted only under exceptional circumstances, and require prior review by both provincial and federal agencies, and necessitate submission of field samples for research purposes.

Under clause 17(b) of **The Environmental Management and Protection Act, a permit is required if pesticides are to be applied to any surface water in Saskatchewan.** This includes intermittent

waterways and drainage ditches, even when dry. The only exceptions are non-draining water bodies, such as dugouts, which are wholly contained on private land. To be exempt, such water bodies must **not** discharge surface water at **any** time to adjacent properties or waterways.

A permit is required for application of pesticides to surface waters and watercourses:

- where "surface water" means water above the surface of the land and being in a river, stream, watercourse, lake, creek, spring, ravine, coulee, canyon, lagoon, swamp, marsh or other body of water; and
- where "watercourse" means a river, stream, creek, gully, ravine, spring, coulee, valley floor, drainage ditch or any other channel having a bed and sides or banks in which water flows either permanently or intermittently.

These waterways are defined to include banks and adjacent lands extending a minimum of 25 metres (82 feet) laterally from the high-water level of such permanent or intermittent waterways, whether wet or dry. In the case of aerial spraying, the adjacent band of protected land is 50 metres (164 feet) from the high-water mark.

Certain areas of Saskatchewan are more sensitive to pesticide effects and may require special protection beyond that provided in these guidelines. In such cases Saskatchewan Environment and Public Safety will notify the individual applicant of any special restrictions.

Permits must be renewed **annually**. Application forms are included in Appendix C. Information and extra application forms may be obtained from:

Water Quality Branch
Saskatchewan Environment and Public Safety
3085 Albert Street
Regina, Sask. S4S 0B1 Phone 787-6181

Table 3 summarizes the regulations and policies which apply to various aspects of aquatic nuisance control.

6.2 Mosquito Control Programs

Mosquito control programs are usually carried out on a municipal-wide basis.

The following are typical conditions which may accompany a permit to apply mosquito control chemicals:

- follow the label guidelines especially those pertaining to the use of the chemical around food crops or populated areas.
- advise any users of water to be treated. The label on the chemical container should provide information on the use of treated waters. (Further information may be obtained from Agriculture Canada, Food Production and Inspection Branch, Regina 780-5180 or Saskatoon 975-4240.);
- the pesticide applicator requires a commercial operator's licence. (Further information may be obtained from Saskatchewan Agriculture, Soils and Crops Branch, Regina 787-4660.);
- obtain permission from the owners of land on which you wish to treat bodies of water. This includes bodies of water such as sloughs which are only partially contained on private land. The applicant may be responsible for providing alternate water supplies for these landowners if activities such as cattle-watering must be discontinued due to the chemical treatment;
- post notices on any water bodies on public land advising that the treatment has been made and providing a contact telephone number for information;
- undertake some type of public information program in the local media such as advertising the mosquito control program in the town newspaper. Mention that the public may learn from the local government office which water bodies and sloughs are involved;
- the chemical applicators or operators should be checked for cholinesterase activity (a standard medical test) as some of the chemicals inhibit the activity of this enzyme; and
- if the mosquito control area is upstream from or adjacent to a water supply that is used for domestic consumption, larviciding should be restricted to areas greater than 25 metres (82 feet) away from the current surface water level. Should the water level rise and encroach on the treatment area, immediately notify both the local water authority and Saskatchewan Environment and Public Safety at 787-6178 (in an emergency call the Saskatchewan Environment and Public Safety 24 hour number at 1-800-667-7525). In such a case the water intake should remain closed until the water level recedes or a chemical analysis shows that there are no mosquito control chemicals in the water.

Table 3
Summary of Policies and Regulations

Activity	Permits Required/Policies	Contact
— application of pesticides to surface waters and adjacent lands — chemical control of aquatic nuisances (e.g. weeds, algae, mosquitoes, leeches)	— a permit is required from Saskatchewan Environment and Public Safety for application of pesticides to waterbodies. — see section 6 for additional information and Appendix C for application forms.	Water Quality Branch Saskatchewan Environment and Public Safety, 3085 Albert Street, Regina, Sask. S4S 0B1 787-6181
— registration of pesticides	— Agriculture Canada places restrictions on how and where chemicals may be used. — product restrictions are listed on the container label. — it is illegal to import or use pesticides (even on your own land) unless the products are registered in Canada for the intended use.	Food Production and Inspection Branch Agriculture Canada 2100 Broad Street, Regina, Sask. S4P 4E1 780-5180 or 1420-606 Spadina Cres., Saskatoon, Sask. S7K 3H1 975-4240
— alteration of shorelines including mechanical removal of rooted vegetation	— a shoreline alteration permit may be required for the mechanical removal of rooted aquatic vegetation.	Fisheries Branch Saskatchewan Parks and Renewable Resources 3211 Albert Street, Regina, Sask. S4S 5W6 787-2884 or your local conservation officer
— fish stocking (e.g. to control mosquitoes or leeches)	— approval required for fish stocking	local conservation officer, Saskatchewan Parks and Renewable Resources

Table 3 — Continued

Activity	Permits Required/Policies	Contact
— operating as a commercial applicator of chemicals	— commercial applicators must be licenced by Saskatchewan Agriculture	Soils and Crops Branch Saskatchewan Agriculture 3085 Albert Street, Regina, Sask. S4S 0B1 787-4660
— accidental spills of pesticides	— regulations require prompt reporting and clean-up of spills — see Appendix A for additional information	Emergency (1 or 112) 800-667-7525 24 hour toll free. Technical information: Land Protection Branch Saskatchewan Environment and Public Safety, 3085 Albert Street, Regina, Sask. S4S 0B1 787-6185
— draining wetlands or modifying stream channels (e.g. for reduction of mosquito habitat)	— drainage permit required for drainage works which drain water onto land not owned by the applicant	Saskatchewan Water Corporation. Contact your regional office.
— disposal of pesticide containers	— regulations require proper disposal of pesticide waste and containers — see Appendix B for additional information	local R.M. office or Waste Management Division Saskatchewan Environment and Public Safety, 3085 Albert Street, Regina, Sask. S4S 0B1 787-6186

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Appendix A

Environmental Spill Control

In case of spills, accidents or fires involving pesticides:

Call

Local Police, Fire Department and Ambulance as required and

Call

Spill Report Centre
Toll Free 1 or 112-800-667-7525 (24 hour)
Outside 306 Area Code call collect (306) 787-8000.

Call immediately to provide available information.

Your first or subsequent call should provide this information:

- the location and time of the spill (e.g., city, town, address, highway number);
- the type and quantity of pollutant spilled (product name, volume spilled);
- the cause and potential effects of the spill;
- a description of the spill site and the immediately surrounding area (soil type, surface water drainage characteristics, ground water depth, proximity to dwellings, location of domestic service lines, etc.); and
- details of actions taken and proposed (containment work at time of spill; details of clean-up and restoration procedures; and details of disposal including location and procedures).

What Can You Expect of the Spill Control Centre?

- you will be given spill clean-up advice;
- a spill response team, available around the clock, will confirm the adequacy of measures taken to contain and clean up the spill and/or give instructions on measures to be taken;
- the centre will act as a liaison with other agencies that might be affected, for example, community officials, the provincial Emergency Measures Organization, the Department of Labour and the federal government;
- the spill response team may make an on-site inspection to determine if appropriate measures are being taken during the clean-up operation, and to ensure that spilled materials are properly cleaned up and disposed of; and
- the centre can advise you of further reporting and procedures that may be required.

Other Spill Control Information:

Technical Details

Land Protection Branch — 787-6185
Saskatchewan Environment and Public Safety
3085 Albert Street
Regina, Sask. S4S 0B1

General/Printed

Administration and Communications Branch — 787-6127
Saskatchewan Environment and Public Safety
3085 Albert Street
Regina, Sask. S4S 0B1

Appendix B

Pesticide Waste and Container Disposal

Introduction

These guidelines on the proper disposal methods for pesticide (herbicides, insecticides, fungicides, etc.) waste containers are essential because:

- improper disposal may damage life and environment;
- pesticide labels commonly provide the user with limited disposal information. In many cases, such information is omitted altogether;
- Saskatchewan Regulation 198/72 (Section 29) under The Public Health Act prohibits the depositing of:

  "Pesticides, herbicides and other toxic substances, and any materials treated with those substances, including the receptacles containing them" at dry disposal sites or in cells within a waste disposal ground;
- the Pest Control Products Regulations (Section 9) under The Pest Control Products (Saskatchewan) Act, 1973 — Section 23, also limit pesticide waste and container disposal. These Regulations restrict the options of anyone wishing to:
  - dispose of any pesticide or mixture containing a pesticide, or
  - bury, decontaminate, burn or otherwise dispose of any container that has been used to hold a pesticide, **to the use of private (not municipal) property**, and further stipulates that materials treated with pesticides, receptacles containing or having contained pesticides, whether damaged, obsolete, or partially full, shall be kept in storage adequately protected from children or animals or shall be destroyed or decontaminated in accordance with instructions provided by the manufacturer; and
  - with the 1984 implementation of the Saskatchewan Pesticide Container Disposal Program, triple-rinsed empty containers now can be delivered to a designated collection site in your area. For further information contact:

    Your Local Rural Municipal Office,
    or
    Saskatchewan Environment and Public Safety
    Land Protection Branch
    3085 Albert Street
    Regina, Sask. S4S 0B1 Phone 787-6186

How to Carry Out Disposal

First, Decontaminate

- decontamination reduces danger to persons handling the container during disposal;
- a pesticide container is never completely empty when the contents have been removed. Therefore, also rinse it out with the same diluent used for mixing. Add the rinse to the spray mixture. It is also a good practice to wash the outside of the container; and
- in addition to rinsing with the diluent, it is preferable for all containers, and a must for those having held highly or moderately toxic material, that they be further decontaminated. This may be done as follows:
  - for each 50 litres volume capacity, pour 5 litres of water, 200 grams of caustic soda (lye), and 50 grams of detergent into the container. Close all container openings. Rotate the container so that all inner surfaces are wetted. Wait at least 15 minutes, and preferably longer, before emptying into a pit isolated from farm animals, housing, and bodies of water. Mark the pit so that it will not be distrubed. During the waiting period, occasionally agitate the container to again wet all inner surfaces. After emptying, flush the container with clean water. Dispose of the decontamination mixture, and flush-water, by burial in the pit.

Only Then, Dispose

- **regular disposal** is necessary. Waste pesticides and empty containers should not be stored too long. Any that do accumulate must be kept in secure storage until proper disposal can be effected. Pesticide waste and containers must never be disposed of haphazardly. Their disposal must be such that no damage is caused to life and the environment.
- **recycling** is the preferred disposal method. It solves the disposal problem and contributes to resource conservation. Containers are usually returned to the original supplier or a reconditioning company. Equipment for reconditioning drums that have held pesticides has yet to be installed in Saskatchewan.

  Consequently recycling drums necessitates their shipment to eastern Canada to a recycling centre. They must be decontaminated and must have all lids and caps on, and labels securely attached.

  Even though containers have been decontaminated, they still require reconditioning before reuse. Great care must be taken to ensure that containers decontaminated for recycling are not used for any other purpose.

- **burning, under very special conditions**, is second-best. This is suitable for containers and pesticide waste only when it is done in an incinerator equipped to collect dangerous combustion products, and operating at a minimum temperature of 1,100°C (2,000°F) to ensure complete chemical combustion and decomposition.
- under no circumstances should empty pesticide containers and pesticide waste be burned on an open fire. Smoke and fumes produced may be highly poisonous. Explosions may occur.
- if recycling, proper incineration or delivery to a designated collection site is not possible, waste must be **buried**. Consult Saskatchewan Environment and Public Safety (787-6186) for the special procedures which must be followed.

Appendix C

Application Form for Aquatic Pesticide Use
(see following page)